Counterfeit Currency

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Glossary

Feathering A term used to describe small ink extensions along the edge of an intaglio printed image. These are caused by some of the ink being forced into the spaces between individual paper fibers from the extreme pressure of the intaglio printing process.

Intaglio A printing technique in which the reversed image is incised into the surface of a printing plate. This technique produces a raised image on the printing surface.

Letterpress A printing technique in which a reversed, raised image on a printing plate is inked and applied to the printing surface.

Offset lithography A printing technique in which the inked image is transferred from a printing plate to a rubber blanket and then to the printing surface.

Optically variable device An image that exhibits various optical effects such as movement or color changes.

Planchettes Distinctive, small disks added to paper stock during the papermaking process. These disks can be made of a variety of materials and may possess properties allowing them to serve as security features.

Thin-layer chromatography A technique used to separate a mixture into its components using a sheet of glass or plastic that is coated with a silica gel.

Genuine Currency

To successfully determine if a banknote is counterfeit, the characteristics of the corresponding genuine banknote must be understood. Genuine banknotes are mass produced to a set of standards and specifications while no such standards exist for counterfeits. Identifying a counterfeit is done by confirming that it does not meet the specifications of a genuine banknote.

The materials and methods used to produce genuine currency are selected for their difficulty to counterfeit as well as for their durability. Banknotes will go through extensive handling and equipment processing during their lifetime, so it is vital that the materials used be able to withstand these treatments along with routine wear and tear due to circulation. Materials are selected for their distinctiveness and are often manufactured specifically for security documents and are not commercially available. The printing of banknotes utilizes the traditional printing processes such as intaglio, typography, and offset on high-quality rag paper or polymer substrates. The specialized security inks are also selected for their durability and functionality within the overall banknote design.

Genuine Currency Substrates

Traditionally, the substrate chosen for banknotes has been a highly durable, uncoated, ultraviolet (UV)-dull rag paper made from either cotton or linen or a combination of the two. Fillers, binders, and other distinctive materials, such as security fibers or planchettes, can be added during the papermaking process for added security and durability. These materials may be natural or synthetic and help distinguish the security substrate from commercially available paper stock. Security fibers or planchettes may contain materials for overt, covert, or forensic identification.

There are other types of security features that can be inserted during the papermaking process. These features may be embedded entirely in the paper or weave in and out of the paper for a windowed effect. The most common of these is in the form of a security thread which can also contain additional properties such as UV fluorescence or the appearance of movement as well as machine-readable features to assist with authentication. Security watermarks are another feature that can be incorporated during the papermaking process. Traditional portrait watermarks are created by depositing paper fibers in varying densities to produce a shadowed appearance. Electrotype watermarks are created by reducing paper thickness in determined areas to produce lighter areas and increase the visibility of the desired image within the paper.

As technology has advanced so has the sophistication of the substrates available for use. Polymer substrates have advanced and offer a durability advantage over paper substrates. Polymer substrates are resistant to tears and folds because of its nonporous and nonfibrous composition. Polymer substrates can incorporate the same security features as paper substrates; however, there are additional security features that can be incorporated into polymer that are unavailable to paper. One of these is a transparent window containing an optically variable device.

Genuine Currency Printing Processes

The three printing processes commonly used to produce genuine currency are intaglio, letterpress, (typography), and wet or dry offset. Screen printing may also be utilized to apply specialized features. Any combination of these printing processes can be found on most currencies.

Intaglio

Historically, intaglio printing has been used for engraved artwork, invitations, and banknotes. The image that was to be printed was engraved by hand into a metal plate using lines and dots of varying length and depth. A very opaque, viscous ink is forced into the engravings, while the plate surface is kept clean. The high pressure of an intaglio printing press forces the substrate into the engravings where it adheres to the ink and

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the image is transferred. This type of printing is desirable for security documents such as banknotes because of its unique characteristics. The thick intaglio ink will produce an image with a raised, embossed texture that is extremely difficult to achieve using other methods of printing. Another unique characteristic of intaglio is the 'feathering' it produces along the edges of printed areas. These patterns of ink spread along individual paper fibers, along with the tonal qualities that intaglio is capable of producing, help give the image area a more life-like appearance (Figure 1). Advances in technology have led to the use of computer-assisted laser devices to engrave the intaglio plates.

Letterpress (typography)

Letterpress printing involves applying ink to a raised surface which is then transferred to the desired substrate by direct impression. One of the characteristics produced by this method is a slight indentation or embossing of the paper from the impression. Another characteristic is the slightly darker and thicker outline of a letterpress image area due to the excess ink being squeezed toward the edge (Figure 2). This type of printing is typically used to add unique identifying information to banknotes such as serial numbers.

Offset

Offset lithography is a flat printing process with none of the characteristics typically found in intaglio or letterpress images. This style of printing is commonly used in commercial industry for printing high-volume items such as newspapers. Wet offset produces images on a flat, metal printing plate for single color printing. Chemical differences between the image and nonimage areas allow for the image areas to accept ink and the nonimage areas to resist ink. Unlike most traditional printing processes such as intaglio and letterpress, where the printing plates come into direct contact with the substrate, offset is an indirect printing process. The ink is first transferred from the printing plate to a transfer plate or 'blanket' and then to the desired substrate.

The main characteristic of offset printing is that the image area appears sharp and even with very crisp lines and edges (Figure 3). There will not be any 'feathering' as seen with intaglio or a dark outline due to ink build up as often seen with letterpress. Because it is an indirect printing process, there will not be any embossing of the substrate from contact with the printing plate.

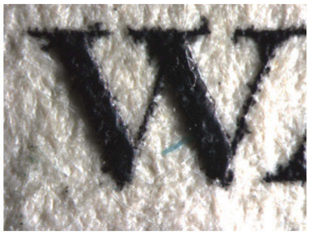
Figure 1 Genuine intaglio printing on US currency.

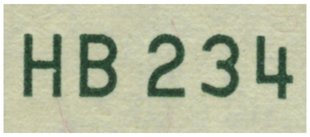
Figure 2 Genuine letterpress (typography) printing on US currency.

While offset printing is used commercially for a variety of items, it allows for additional layers of security in the printing of documents such as banknotes. More advanced offset presses are capable of exceptionally tight registration between images on the front and back of the document as well as the ability to print extremely fine interwoven lines of varying color saturation. This produces images with qualities that are very difficult for counterfeits to reproduce whether using traditional or digital methods.

Dry offset is another form of offset printing that uses a raised image area but still utilizes the transfer 'blanket.' Images produced this way may have some of the same characteristics of letterpress but the substrate will not demonstrate any signs of embossing.

Screen printing

The screen printing process uses a stencil and screen to produce images. Ink is forced through the screen onto the substrate. The ink used is very thick resulting in a slightly raised image; however, the pattern of the screen can sometimes be seen along the edges of images produced with this process and because no considerable pressure is applied, the substrate will not demonstrate any embossing (Figure 4). Screen printing is commonly used to apply specialized optically variable features to banknotes.

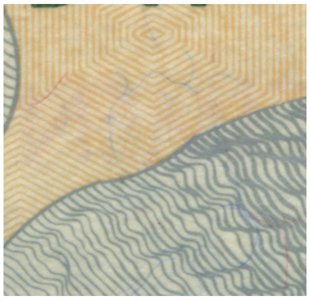
Figure 3 Genuine offset printing on US currency.

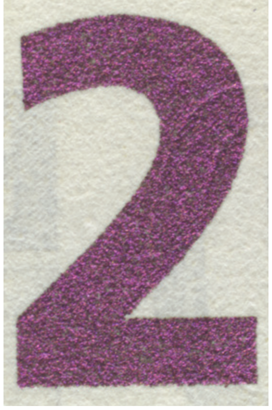
Figure 4 Genuine screen printing on Euro banknote.

Applied Security Features

The security of a banknote is only as good as the security of the design. There are many options for features that can be incorporated into the design. Holographic features are widely used in many security documents including currency and are a challenge for counterfeiters to simulate.

Currency Authentication

Authenticating any document requires an understanding of the genuine and the security features it should contain. This means the quality of the genuine production process is vital to ensure a product that can be consistently recognized and authenticated as genuine. Natural variation can occur in any production process but these variations must be understood and documented to eliminate any confusion. If a banknote does not fall within these known ranges of variation, then it can be determined to be counterfeit. Experienced cash-handlers scrutinize banknotes for their security features and will recognize variations in quality very easily while someone less experienced may simply rely on the image. Counterfeiters can take advantage of untrained individuals by creating a counterfeit with high image quality but lacking in many of the other security features that a trained cash handler would check.

Machine authentication of banknotes utilizes specific features in the currency designed to be machine readable. If a counterfeiter's goal is to defeat these types of authentication devices, they will often focus their attention on these machine-readable features and ignore the quality of the image on their counterfeit.

Counterfeit Examinations

Microscopy continues to be the most advantageous method for examining suspect counterfeit banknotes. The magnification can range from 7 to 40× for observation of security features and printing process characteristics allowing for retail establishments to have a small, handheld magnifier, such as a linen tester, to check suspect counterfeits. More complex examinations, such as paper fiber assessments, will require higher magnification from 40 to 100× and are often reserved for the forensic document examiner or counterfeit specialist. Alternate light sources ranging from the near infrared to the UV are also necessary. More extensive examinations can be performed with specialized equipment that requires operator expertise but can lead to valuable forensic and investigative information.

Physical Examination with Light Sources

Physical examination of the suspect counterfeit can first be done using standard and transmitted light and a direct comparison to a known genuine image. Standard reflective light allows for the color and presence of overt security features to be evaluated and compared. Using reflective light at an oblique angle will allow for the viewing of the substrate's topography as well as observation of optically variable features such as optically variable ink (Figures 5 and 6).

Transmitted light allows the examiner to view embedded security features such as threads and watermarks which by design should only be able to be observed with transmitted light (Figures 7–10). Any misalignment of front-to-back registered features can also be detected using transmitted light and may be the indication that a suspect banknote is counterfeit.

UV light sources allow the examiner to observe the UV brightness of the suspect substrate. While most commercial papers have optical brighteners added to them, currency paper substrates inherently possess a UV-dull response. Post-issuance chemical exposure however can result in genuine currency

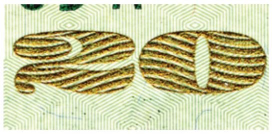

Figure 5 Genuine optically variable ink (OVI) copper color on US currency.

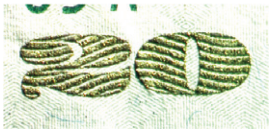

Figure 6 Genuine optically variable ink (OVI) green color on US currency.

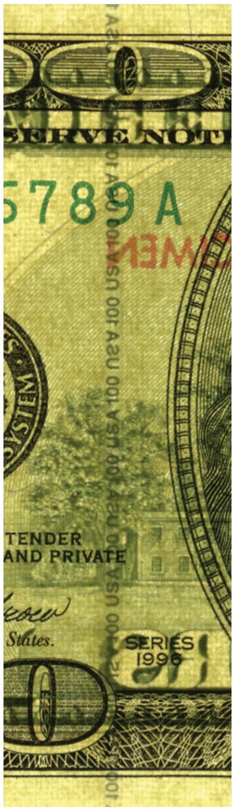

Figure 7 Genuine embedded security thread.

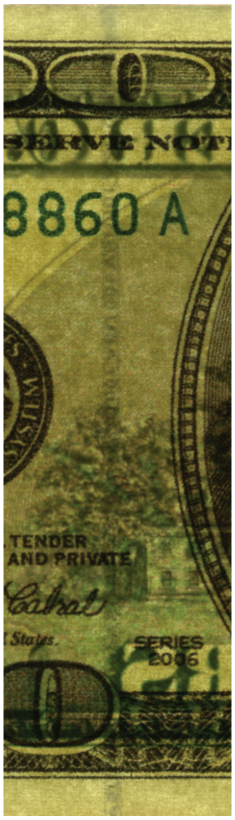

Figure 8 Security thread simulated by printing on counterfeit US currency.

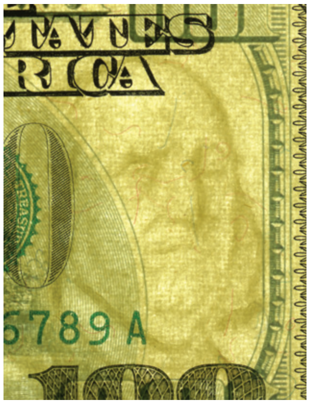

Figure 9 Genuine security watermark.

paper substrates obtaining a UV response, so this examination should always be combined with other examinations to confirm if a banknote is counterfeit. Security features incorporated into banknotes may also possess UV properties. A UV light source will allow the examiner to determine if UV properties are present but can also reveal simulated security features on counterfeit banknotes (Figures 11–13). Since the materials used to print these simulated features will often absorb or reflect UV light, they can be viewed in a distinguishable manner from genuine substrates.

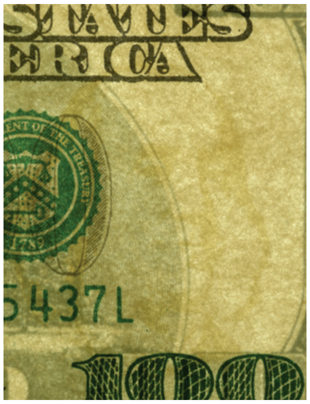

Figure 10 Security watermark simulated by printing on counterfeit US currency.

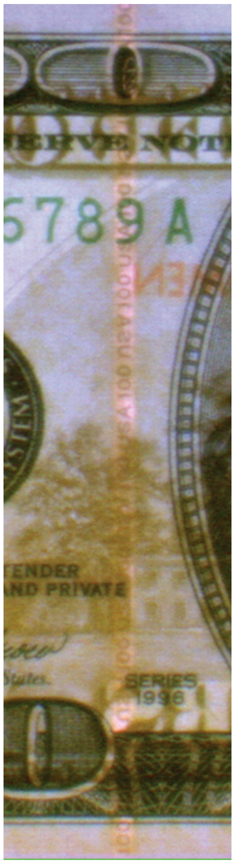

Figure 11 Genuine ultraviolet response.

Physical Examination with Microscopy

Microscopy is one of the most valuable tools an examiner can use when conducting physical examinations of suspect counterfeit banknotes. Paper substrate composition, security features, and side-by-side comparisons of the intricate banknote design can all be done with various microscopy sources.

The physical characteristics, for example color and morphology, of substrate-based security features such as fibers, planchettes, and threads can be microscopically examined

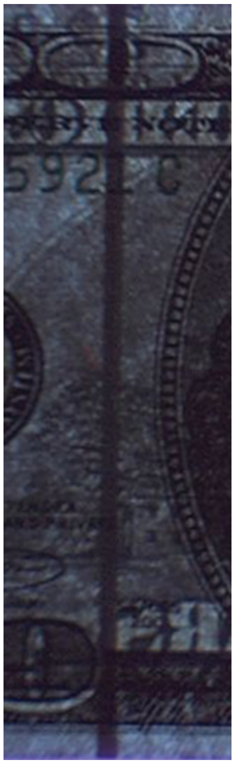

Figure 12 Counterfeit US currency showing no ultraviolet response of the security thread simulation.

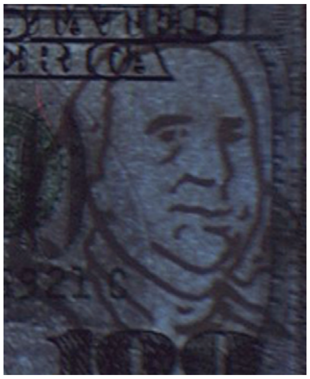

Figure 13 Ultraviolet response of a printed watermark simulation on counterfeit US currency.

and compared to the genuine specimen. The location of these features can also be evaluated. While genuine fibers, planchettes, and threads are embedded in the substrate, counterfeit features can be simulated by printing or gluing them to the surface. More sophisticated counterfeits will have embedded features, but microscopic examination will reveal difference in the color, morphology, or composition of these counterfeit features when compared to genuine specimens.

Microscopic analysis will also reveal security features that may not have been successfully reproduced by the printing technique chosen by the counterfeiter. Microprinting, for example, is small text that cannot be reproduced by low-resolution digital technology such as scanners and will often be illegible on counterfeits that use that technology to acquire an image. More recently, however, the resolution in affordable digital technology has increased to where some of these devices will successfully reproduce microprinting from the genuine image (Figures 14 and 15).

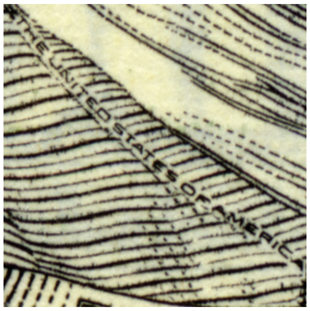

Figure 14 Genuine microprinting on US currency.

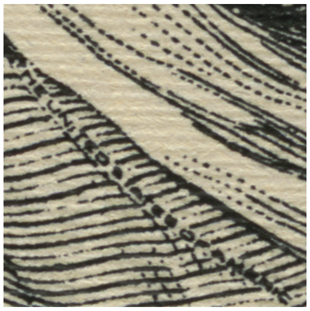

Figure 15 Counterfeit microprinting reproduction.

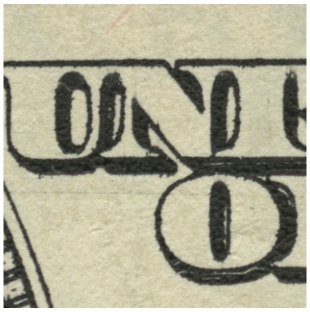

Figure 16 Counterfeit intaglio printing.

Microscopy is the best tool to determine the printing method used to produce the suspect counterfeit banknote. Different methods of printing have different characteristics that can be observed with magnification. The four printing processes used to produce genuine currency, intaglio, letterpress, offset, and screen, have been discussed but counterfeit versions of these printing processes can be used and will possess similar characteristics as their genuine counterparts (Figures 16–19). The following printing processes are also known to be used to produce counterfeits.

Halftone offset lithography

If a counterfeiter wants to use offset lithography to entirely produce their counterfeit image, they will sometimes use

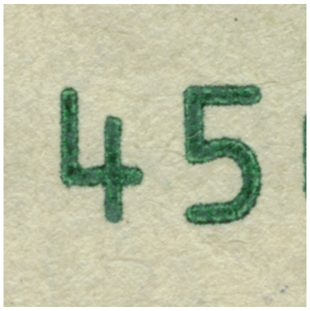

Figure 17 Counterfeit letterpress (typography) printing.

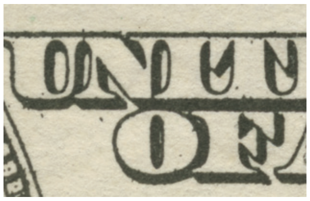

Figure 18 Counterfiet offset printing.

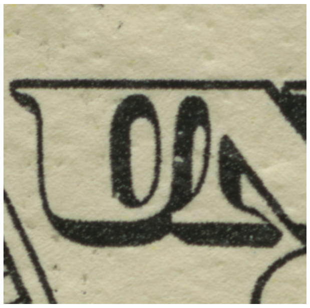

Figure 19 Counterfeit screen printing.

halftone offset because of its ability to produce tonal variations that regular offset lithography cannot. A screen or computer is used to break up the desired images into a series of dots that range in size and location and once combined together will create the illusion of a continuous tone. If full color separation is desired to simulate the various shades and colors of the genuine currency, a full color halftone process can be used in which the subtractive color mixture of cyan, yellow, magenta, and black (CMYK) are used in various combinations to create the illusion of the distinct colors contained in the genuine image (Figure 20).

Laser technology

Digital devices that use dry toner such as copy machines and laser printers will produce images composed of tiny plastic particles that have been fused to the surface of the substrate. Under magnification, the image will resemble melted plastic with stray toner particles scattered along the edge of the image area (Figure 21).

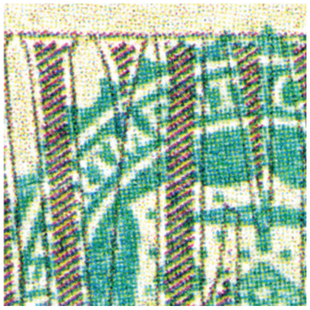

Figure 20 Counterfeit halftone offset printing.

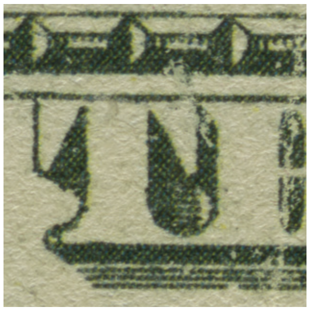

Figure 21 Counterfeit full color toner printing.

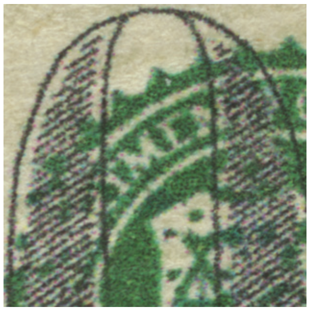

Figure 22 Counterfeit inkjet printing.

Inkjet technology

Inkjet-produced images are composed of ink dots that have absorbed into the paper. These dots will be flat and irregularly shaped. Legacy inkjet devices used basic CMYK components but newer devices have the ability to use a vast array of color options (Figure 22).

Bleached Currency Examinations

Paper currency substrates possess unique characteristics and a unique 'feel' that is often recognized as currency. Because of this, some counterfeiters want to use currency paper to produce their counterfeits. They will 'bleach' or chemically remove the ink from low-denomination banknotes leaving a blank piece of currency paper for use as a substrate for their counterfeit image. The image of a higher-denomination banknote is printed on the genuine currency paper, which will possess any

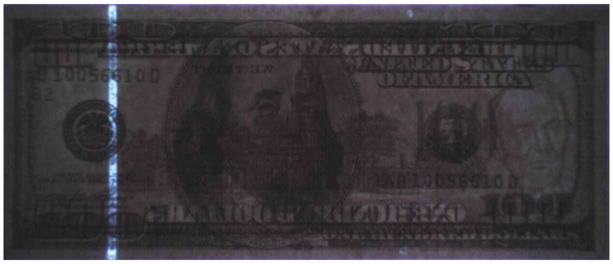

Figure 23 Bleached genuine $5 printed as a counterfeit $100 showing retained $5 security thread and security watermark.

paper-based, embedded security features of the denomination that was bleached, making it a more deceptive counterfeit (Figure 23).

An examination of bleached counterfeits may reveal signs of the process. The process of bleaching involves not only the use of chemicals but also the abrasive process of removing the ink from the paper. A microscopic examination of a bleached counterfeit may reveal a disruption in the genuine paper fibers from this process as well as the removal of the paper's surface sizing. This will result in the topography and color of the bleached paper being distinguishable from original genuine paper. Residual images of the original banknote may also remain if the bleaching process was not completed correctly. Any postbleaching steps taken by the counterfeiter to improve the bleached paper's texture or printability can be detected microscopically.

Inkjet Examinations

Thin-layer chromatography is a common and rapid technique used to separate the organic components of inkjet inks and provide an easy side-by-side comparison of the dyes in the ink formulations. While a conclusion can be made that the inkjet chromatogram is consistent with a specific manufacturer of inkjet ink, it cannot be used to conclusively link a suspect inkjet printer to a suspect counterfeit banknote and should be supported by other investigative or forensic information.

Counterfeits will commonly use an all-in-one inkjet printer and use the scanning capability to obtain the image from a genuine banknote. When this procedure is used, any defects on the scanner glass or lid such as dirt or scratches can be detected in the printed sheets of counterfeits. These 'trashmarks' can help conclusively link a suspect inkjet printer to the counterfeit that was produced from that printer.

Chemical and Instrumental Examinations

Spectroscopy, elemental analysis, and chromatography of components such as the paper and ink of the suspect banknote may also be utilized to compare a suspect banknote to genuine and obtain valuable information that may benefit a counterfeit investigation. Research efforts have focused on characterizing specific inkjet inks using methods such as Raman spectroscopy. While these methods may not be necessary when simply determining if a suspect banknote is counterfeit, they could provide valuable investigative information when needed.

Summary

Paper currency is a method that has been used throughout history to purchase or trade goods and services. As long as paper currency has been used, the threat of counterfeiting has existed. Being able to recognize printing processes and security features used to produce genuine currency will assist an examiner in identifying a counterfeit as many methods used to produce counterfeit differ from the genuine methods.

See also: **Documents:** Analytical Methods; Forgery/Counterfeits; Ink Analysis; Paper Analysis.

Further Reading

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